SP-W2 Contaminant Accumulation in Fish, Sediments, and the Aquatic Food Chain

October 25, 2002

1.0 Introduction/Background

The Environmental Work Group has identified contaminant accumulation in fish, sediment, and the aquatic food chain as an issue of concern. Contamination of fish from mercury and other metals and organic contaminants is a significant concern in many areas of California, including the Feather River watershed. Lake Oroville tributaries in the upper Feather River watershed experienced significant gold mining activity during the Gold Rush era, and continue to experience significant recreational gold mining activity. Numerous large mercury mines were developed in the Coast Range to supply mercury as an amalgam for gold extraction in the Feather River and other areas. Mercury lost to the tributaries during gold mining operations is slowly being transported downstream with sediments. Though the Gold Rush era has long since passed, significant quantities of mercury still remain in the streams tributary to and in Lake Oroville.

Potentially occurring anoxic conditions beneath the sediment-water interface at the reservoir bottom create ideal conditions for biologically mediated liberation of methyl mercury by sulfate-reducing bacteria. The redistribution of methyl mercury in the water column during lake mixing in the fall and winter may facilitate bioaccumulation into the food web, including plankton, fish, and piscivorous birds and other animals, including humans

In addition, other industrial activities in the upper Feather River watershed have contributed metal and organic contaminants, including polychlorinated biphenyls (PCBs), which also have an affinity for sediments and bioaccumulate in the food web. Re-suspended sediments and recycled metals and organic contaminants in Lake Oroville can be transported downstream to other project waters, including the Diversion Pool, Thermalito Afterbay and Forebay, Oroville Wildlife Area ponds, and the Feather River, where uptake and bioaccumulation in aquatic organisms can occur.

Sediments trapped behind the dam are potentially laden with metals and organic contaminants, which may bioaccumulate in the food web. Sediments carried into Lake Oroville initially deposit into the upper tributary arms. Sediment deposits are transported further into the reservoir due to: 1) natural high flow hydrologic events; 2) reduced reservoir levels, and 3) periodic discharge surges from upstream hydropower generation.

2.0 Study Objective

The objectives of the study are to determine 1) the magnitude and extent of bioaccumulation of metals and organic contaminants in aquatic organisms within the project-affected area, and 2) the sources and potential pathways of contamination that contribute to bioaccumulation including contaminated sediments deposited as a result of project features, operations, and maintenance., and to provide information that could be used to develop potential protection, mitigation and enhancement measures.

3.0 Relationship to Relicensing/Need for the Study

Sediments in Feather River tributaries are known to carry metal and organic contaminants. Prior to construction of Oroville Dam, sediments carried by the tributaries and the main stem of the Feather River in the reservoir footprint were transported downstream. Subsequent to completion of the dam, sediments carried by the tributaries settle into the upper arms of Lake Oroville, but are reworked by stream flows as reservoir levels drop throughout the summer and are redeposited further into the reservoir area. Thermal stratification in the reservoir during the summer can facilitate the leaching of metals and organic contaminants from the sediments into the water column, where they become available for uptake by aquatic life or release downstream. In addition, sediment dwelling organisms (e.g., crayfish, insects) ingest the sediments and can absorb contaminants. Contaminants in lower trophic levels are bioaccumulated in higher trophic level organisms, and may reach levels that are deleterious to other organisms (including listed species and humans) that ingest them.

Impoundment of the reservoir created conditions in which sediments possibly laden with contaminants are trapped, which could then allow bioaccumulation of contaminants in the food web. Water with bioavailable forms of metals and organic contaminants that is released from the reservoir may contribute to bioaccumulation in downstream organisms. Bioaccumulation may not have been significant downstream from the dam prior to its construction because the metals and organic contaminants were bound to the sediment particles, not readily available for uptake, and transported out of the system with higher flows.

The California Department of Water Resources and State Water Resources Control Board have conducted limited sampling for metals in some fish from the reservoir and Feather River downstream from the dam. Analyses of the few fish from Lake Oroville and the Feather River have detected mercury at concentrations that exceed current U.S. Environmental Protection Agency and California Office of Environmental Health Hazard Assessment criteria. These data are not sufficient to determine the magnitude and extent of mercury contamination in fish and other organisms, nor the source. Additional analyses of fish tissue for mercury and other metals and organic contaminants is necessary to determine project effects and compliance with Basin Plan objectives.

A variety of wildlife species prey on fish or other aquatic species from project waters. These wildlife species could suffer adverse physiological or reproductive responses from ingestion of prey species containing elevated levels of certain contaminants. Contaminants ingested by wildlife species that prey on aquatic species from project waters can also be bioaccumulated and passed on to other predatory fish and wildlife species that in turn prey on them.

Since recreation, including fishing, is a major beneficial use at project facilities, analysis of fish tissues would provide valuable information for fish consumption advisories. Sampling of sediments may be necessary to determine whether contamination of biota (if found) is attributable to contaminant sources located within the reservoir or upstream from the project area and if contamination is local or widespread. Certain areas may be less contaminated than others and not warrant the same restrictions as other reservoir locations for consumption of fish. This could only be determined by analyzing sediment samples, since identification of fish with high contaminant loads in a particular area may be due to their recent migration into the sampling area from other contaminated sites. Knowing the location and extent

of sediment contamination can help determine and develop reservoir management practices (licensing conditions) that improve the overall water quality and natural and recreational resources of the reservoir.

In addition, some contaminants are not strong bioaccumulators (e.g., some metals such as copper and arsenic), but may be mobilized and made available to the biota under certain environmental conditions (resuspension of sediment deposits from the arms to the main body, depressed oxygen and pH conditions, etc.) found in the reservoir. Organisms can become re-exposed to contaminants as the lake level drops and deposited sediments are resuspended and transported further into the reservoir. The shallow, relatively warm, organic rich waters of the Forebay and Afterbay could contribute to the methylation of mercury and dissolution of other metals and organic contaminants. Environmental conditions such as these in project water bodies may promote mobilization of sediment bound contaminants and transport out of the "project area" where they could affect threatened and endangered species.

Sediment contamination information can be used to determine where to focus efforts to reduce sediment loading to improve water quality in the reservoir.

Demonstration of compliance with basin plan objectives is necessary for the SWRCB to issue a water quality certification. Basin plan objectives include provisions against increases in suspended sediment discharges and deposition of material that adversely affect beneficial uses, and toxic substances that produce detrimental effects to humans, plants, animals, and aquatic life. The water quality certification is needed for license renewal with the Federal Energy Regulatory Commission. Information derived from this study will be used to demonstrate compliance with water quality standards and other appropriate requirements in the application for water quality certification. Information from the study is also needed to address USFS, USFWS, and NMFS concerns related to fish and wildlife species that feed on potentially contaminated aquatic organisms in the project area.

4.0 Study Area

The study area is generally within the FERC project boundary, but also includes lands adjacent to the project boundary where piscivorous species may occur. The first phase of this study will focus on evaluation of contaminants in project waters. Phase Two, if necessary, will evaluate contamination in reservoir tributaries and the Feather River downstream from the project area.

Study plans approved by the Environmental Work Group define the limits of the study area. If initial study results indicate that the study area should be expanded or contracted, the Environmental Work Group will discuss the basis for change and revise the study area as appropriate.

5.0 General Approach

Detailed Methodology and Analysis

This study will be conducted in phases. The first phase will emphasize analysis of metals and organic contaminants in fish, crayfish, and sediments in the Project area. The first phase will collect fish tissues

and sediment samples from 16 locations in the Project area, while crayfish will be collected from four of the sites. Sediment samples will be frozen for later analysis. Results from fish tissue analyses and water quality results from SP-W1 will be presented as soon as results are available from the DFG laboratory for the fish tissue analyses. The Environmental Work Group will use the fish tissue and water quality data to select a minimum of six of the collected sediment samples to be analyzed for at least methylmercury, total mercury, and PCBs. Additional constituents may be analyzed from these six and any or all of the other ten sediment samples based upon results from fish tissue and water quality analyses. Other sediment may be collected to augment the 16 samples.

The environmental compartments analyzed in subsequent phases, if needed, will be determined in consultation with appropriate resource and health agencies and the Environmental Work Group or Task Force. Analyses in subsequent phases in tributaries to the reservoir would provide background data needed to evaluate the role of the reservoir in bioaccumulation. Subsequent analyses in sediments and additional fish in the project area would provide information to determine the extent and sources of contamination, and species affected. The extent of project related impacts to fish, crayfish, and sediments downstream from the project area would also be analyzed in subsequent phases.

If initial study results indicate that the methods and tasks should be modified, the Environmental Work Group will discuss the basis for change and revise the study plan as appropriate.

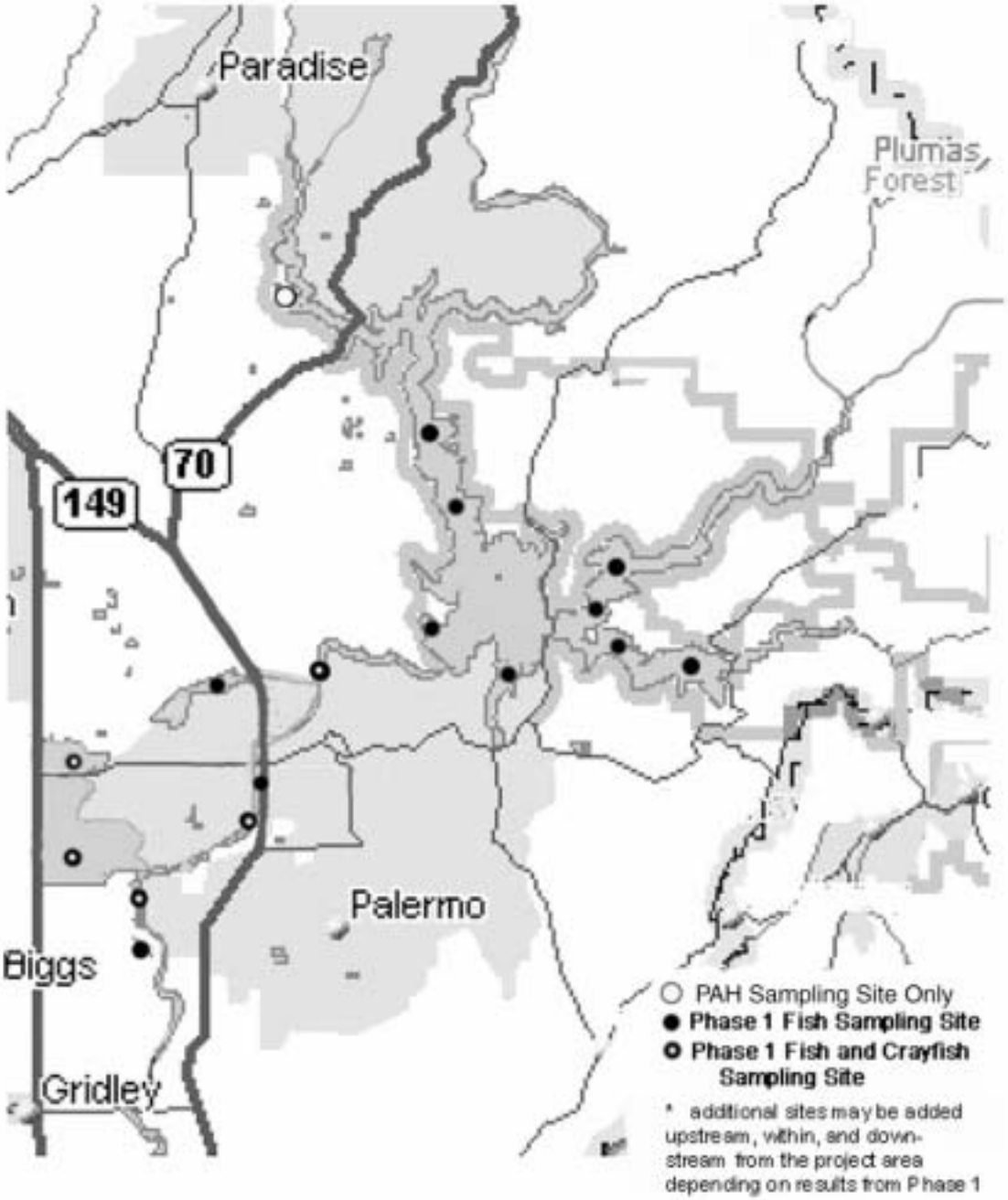
Phase 1—Project Area Metals and Organic Contaminant Assessment

Water bodies sampled for Phase 1 of the study will include Oroville Reservoir, Diversion Pool, Thermalito Forebay and Afterbay, low flow section of the Feather River, Feather River immediately downstream from the Afterbay Outlet, and two Oroville Wildlife Area ponds (Figure SP-W2-1). Tasks that will be undertaken in Phase 1 include sample collection, laboratory analyses, and data interpretation.

Phase 1, Task 1—Sample Collection

Specific fish species sampled is dependent on the types resident in the water body sampled. Newly planted fish (i.e., less than one year residency) will be avoided. One larger size class of a black bass and a catfish species will be targeted from each sampling site. Attempts will be made to collect ten large bass that are a 'keepable' size as defined in the fishing regulations (i.e., greater than 15 inches in total length), while five catfish will be collected from each site. The bass will be individually analyzed for total mercury. Subsequently, five of the bass will be composited for other analyses following the protocol of the California Office of Environmental Health Hazard Assessment. Each composite of bass or catfish will be composed of fish with no greater than 25 percent difference in fork length between the largest and smallest fish. Fish will be collected beginning in the late spring with electroshockers, gill nets, hooks and lines, or seines. Fish will be weighed and measured, wrapped in aluminum foil, and immediately frozen for transport to the laboratory.

Figure SP-W2-1. Phase 1 Contaminant Monitoring Sites



Crayfish will also be collected from several sites within the project area at approximately the same time that the fish are collected. Larger (older) crayfish will be targeted. At least ten crayfish of similar size from each sampled site will be composited. Crayfish will be collected by hand, nets, or baited traps. Crayfish will be wrapped in aluminum foil and frozen for transport to the laboratory.

Sediments will be collected from sites that fish are collected. Sediments will be collected with a sediment core sampler in deeper waters, and with a hand corer or teflon spoons in shallower waters following methods of the USGS (USGS 1994). The top six inches of sediments in ten cores will be composited and subsampled into teflon bottles. Sediments collected with teflon spoons from ten areas at shallow monitoring sites will also be composited and subsampled into teflon bottles. The bottles will be frozen for later analyses (Dave Crane, DFG Water Pollution Control Laboratory, pers. comm.)

Lake Oroville — Screening for fish contamination in Lake Oroville requires multiple sampling sites in each arm and the main body of the reservoir. Fish will be collected from two different sampling sites in each of the North, Middle, and South fork arms and from both the east (Bidwell Marina arm) and west (Spillway arm) sides of the main body of the reservoir. Bottom sediments will be collected at each of these sites. In addition, bass and catfish will be collected from near the Lime Saddle Marina for polynuclear aromatic hydrocarbon contamination analysis. The marina environment is the most likely site for PAH accumulation. Targeted fish species will include spotted, largemouth, or smallmouth bass and channel catfish.

Diversion Pool — The Diversion Pool will be sampled near the Diversion Dam. Fish targeted for collection from the Diversion Pool will include spotted, largemouth or smallmouth bass, and catfish. Crayfish will be collected from the same site.

Thermalito Forebay, Thermalito Afterbay, and Oroville Wildlife Area — One monitoring site will be established in the north Thermalito Forebay. The Thermalito Afterbay will be sampled in both the northern and southern regions. . Two representative ponds will be sampled in the Oroville Wildlife Area. Warmwater fish species targeted in these water bodies will include spotted, largemouth, or smallmouth bass and catfish. Crayfish will be collected from both sampling areas in the Afterbay.

Lower Feather River — The Feather River downstream from Oroville Dam will be sampled at one site in the low flow section between the fish hatchery and Afterbay Outlet and at another site downstream from the outlet within the project boundary. Targeted fish species will include spotted, largemouth, or smallmouth bass and catfish. Attempts will be made to sample the same species as sampled in the other project waters. Crayfish will be collected from either the low flow section or downstream from the Afterbay Outlet in the Feather River.

Phase 1, Task 2—Laboratory Analyses

Analytical procedures generally will follow those used in the Toxic Substances Monitoring Program conducted by the State Water Resources Control Board and Department of Fish and Game. Metals, pesticides, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons are analyzed for this program (Table SP-W2-1). PCB congeners analyzed will be those determined to pose significant ecological risks in a U.S. Environmental Protection Agency sponsored study (USEPA 1998), rather than just those analyzed as part of the TSMP.

Table SP-W2-1. Metals and Organic Contaminants for Analyses

Analyte	Reporting Limit ppb (ng/g)	Analyte	Reporting Limit ppb (ng/g)
Organochlorine Pesticides by EPA Method 8081A			
aldrin	1	dieldrin	1
alpha-BHC	1	endosulfan I	2
beta-BHC	2	endosulfan II	2
gamma-BHC	1	endosulfan sulfate	2
delta-BHC	1	endrin	2
alpha-chlordane	1	endrin aldehyde	2
gamma-chlordane	1	endrin ketone	2
alpha-chlordene	1	heptachlor	1
gamma-chlordene	1	heptachlor epoxide	1
chlorpyrifos	2	Kelthane (dicofol)	2
chlorthal (dacthal)	2	methoxychlor	10
2,4'-DDD	2	mirex	2
2,4'-DDE	2	nonachlor, cis	2
2,4'-DDT	2	nonachlor, trans	2
4,4'-DCBP	2	oxadiazon	2
4,4'-DDD	2	oxychlordane	2
4,4'-DDE	2	tetradifon (tedion)	2
4,4'-DDT	2	toxaphene	100
4,4'-DDMU	2		
Polynuclear Aromatic Hydrocarbons by EPA Method 8270C/SIM			
acenaphthene	10	fluoranthene	10
acenaphthylene	10	fluorene	10
anthracene	10	indeno(1,2,3-cd) pyrene	10
benzo(a)anthracene	10	3-methylcholanthrene	10
benzo(b, j&k)fluoranthene	10	1-methylnaphthalene	10
benzo(g,h,i)perylene	10	2-methylnaphthalene	10
benzo(a)pyrene	10	1-methylphenanthrene	70
benzo(e)pyrene	10	naphthalene	10
biphenyl	10	perylene	10
chrysene	10	phenanthrene	10
dibenzo(a,h)anthracene	10	pyrene	10
2,6-dimethylnaphthalene	10	2,3,5-trimethylnaphthalene	10
Polychlorinated Biphenyls (PCB) Congeners by GC/ECD w/congener standards			
Congener	**Reporting Limit ppb (ng/g)**	**Congener**	**Reporting Limit ppb (ng/g)**

Analyte	Reporting Limit ppb (ng/g)	Analyte	Reporting Limit ppb (ng/g)
8	0.6	128	0.6
15	0.6	132	0.6
18	0.6	137	0.6
27	0.6	138	0.6
28	0.6	149	0.6
29	0.6	151	0.6
31	0.6	153	0.6
44	0.6	156	0.6
49	0.6	157	0.6
52	0.6	158	0.6
66	0.6	167	0.6
70	0.6	169	0.6
74	0.6	170	0.6
77	0.6	174	0.6
81	0.6	177	0.6
87	0.6	180	0.6
95	0.6	183	0.6
97	0.6	187	0.6
99	0.6	189	0.6
101	0.6	194	0.6
105	0.6	195	0.6
110	0.6	200	0.6
114	0.6	201	0.6
118	0.6	203	0.6
123	0.6	206	0.6
126	0.6	209	0.6
Organophosphorus Pesticides by EPA Method 8141A			
chlorpyrifos	2	parathion, ethyl	2
diazinon	20	parathion, methyl	4
Metals by EPA Method 6020 (ICPMS)			
arsenic*	0.02	mercury	0.01
cadmium	0.005	nickel	0.01
chromium	0.1	selenium*	0.02
copper	0.006	silver	0.005
lead	0.007	zinc	0.06
Miscellaneous Sediment Analyses			
Percent organic carbon	EPA Method 9060		
Acid volatile sulfides	EPA ABS/SEM procedures, Dec. 2, 1991		
Nonyl phenols	GC-MS/DFG		

** analysis with methanol addition*

Methylmercury is assumed to be the form of mercury available for bioaccumulation in the food web. Most mercury in fish tissues is in the methylmercury fraction. Total mercury, however, is typically analyzed from fish tissue and is assumed to represent the methylmercury content of tissues. Fish muscle (filet) tissue is analyzed for the metals arsenic, cadmium, nickel, mercury, and selenium, while fish liver is analyzed for copper, zinc, chromium, lead, and silver. All

organic chemicals in fish are analyzed from filets. Whole body analyses of metals and organic chemicals are performed on crayfish. Insufficient information is available to determine whether total mercury analyses can be used to assess the methyl mercury fraction in crayfish. Therefore, both methyl and total mercury will be analyzed from crayfish to assess mercury contamination and the relationship between methyl and total mercury. Crayfish are shelled at the laboratory prior to analysis. All fish and crayfish analyses will be performed at the Department of Fish and Game Water Pollution Control Laboratory in Rancho Cordova.

The ten black bass obtained from each sampling site will be individually analyzed for total mercury contamination. Subsequently, five of the fish from each site will be composited following OEHHA guidelines. The black bass and catfish composites will be analyzed for organic (organochlorine and organophosphorus pesticides, and polychlorinated biphenyls) and metal contaminants. The composites of black bass and catfish collected near the Lime Saddle marina will be analyzed for polynuclear aromatic hydrocarbons.

The composited crayfish samples from each sampling site will be analyzed for organic and metal contaminants, including both methyl and total mercury.

Sediment samples from a minimum of six sites will be submitted for organic and metal contaminant analyses following review by the Environmental Work Group or Task Force of the fish and crayfish analysis results. Sediments from these six sites will be analyzed for mercury, PCBs, and other metal or organic contaminants identified from the fish or crayfish samples at a level of concern. Sediments from additional sampled sites will also be submitted for analyses if the fish and crayfish results indicate contamination at levels of concern. The sediments will be analyzed at the DFG laboratory.

Phase 1, Task 3 – Data Interpretation

Criteria and guidance values for protection of human health and wildlife from contaminant accumulation or ingestion will be researched and reviewed. Some of these criteria and guidance values include numerical criteria of the U.S. EPA and California Office of Environmental Health Hazard Assessment for human health protection, National Academy of Sciences predator protection criteria, maximum tissue residue levels and elevated data levels used by the SWRCB, action levels of the U.S. Food and Drug Administration, and median international standards for trace elements of the Food and Agriculture Organization of the United Nations. Results from Task 2 will be compared to applicable criteria and guidance values. Potential pathways for bioaccumulation in the fish will be investigated for those contaminants present at levels that pose a concern. Pathways and sensitivity to contaminants in wildlife species of management concern will also be reviewed. This review will include evaluation of the potential for accumulation in their aquatic prey for contaminants identified in this study. The pathways investigation will facilitate determination of project operations that may contribute to contaminant bioaccumulation and downstream effects, and focus activities in Phase 2 of this study.

Phase 1, Task 4. Phase 1 Reports

Interim output products will be identified through coordination with other work groups to meet their data needs. A report will be prepared at the conclusion of Phase 1 of the study that discusses results of the study, including relationships to criteria and guidelines, implications for human and wildlife health, and need for Phase 2.

Phase 2—Metals and Organic Contaminant Assessment Pathways

If analyses in Phase 1 or findings of study plan SP-W1demonstrate elevated levels of contaminants in fish or crayfish (i.e., criteria or guidelines exceeded) or water quality conditions associated with enhanced bioaccumulation, a second phase will be undertaken. The Environmental Work Group will review and approve the Phase 2 approach before implementation. It is anticipated that Phase 2 would evaluate sediment, fish, and crayfish contamination in the tributaries to the reservoir to determine background (i.e., upstream) bioaccumulation and contamination levels. Additional sport fish species would be sampled in project waters to determine the extent of species affected and distribution of contaminants and contaminated fish in project waters. Sediments and prey fish species (such as threadfin shad or wakasagi preyed on by other fish and these and larger fish preyed on by wildlife species) may also be sampled for contaminants in project water bodies. In addition, sediment, fish, and crayfish would be sampled downstream from the project area in the Feather River to evaluate the extent of possible project effects on downstream contamination. Parameters analyzed would include both metals and organic contaminants that were found to be significant in Phase 1.

Phase 2, Task 1—Background Assessment

Analyses in Phase 2, Task 1 will focus on tributaries to the reservoir to provide background data needed to evaluate the role of the reservoir in bioaccumulation. Data from tributaries to the reservoir will be compared to that obtained from project waters to determine whether the project had any effect in bioaccumulation above background levels present in the watershed.

Phase 2, Task 1A—Sample Collection

Fish and crayfish species sample collection will use the same procedures and protocols as in Phase 1, Task 1. Fish and crayfish in the North, Middle, and South forks of the Feather River and the West Branch, Concow Creek, and Fall River will be sampled just above their confluences with the reservoir. Targeted fish species will include the same species sampled in Phase 1. If those species are not available, targeted species may include smallmouth bass, catfish, and pikeminnow. (However, resampling of the reservoir would then be necessary to obtain the same species for comparisons).

Sediments will be collected from riffle deposits, point bars, or the bottom of pools. Sediments would be collected with teflon spoons into containers provided by the laboratory. Ten samples would be collected from each site and composited into a single sample. If deposited sediments are found to contain significant loads of contaminants, sediments in the bedload will be sampled for contaminants during the fall, winter, and spring to determine temporal variability in contamination and concentrations in sediments being transported into Lake Oroville.

Phase 2, Task 1B—Laboratory Analyses

Laboratory analyses for fish and crayfish will follow the same procedures as in Phase 1, Task 2.

Phase 2, Task 1C—Data Interpretation

Data obtained from this Phase and Study Plan SP-W1 will be compared to criteria and guidelines to determine whether contaminant levels are present at levels that would pose a concern to human health, aquatic organisms, and the food web, which includes terrestrial species. Contaminant levels in fish and crayfish in the tributaries would be compared to levels in those species from project waters to determine whether the project contributed to additional bioaccumulation of contaminants in those species. The sediment data would be used to evaluate the contribution of contaminant loading from each tributary to focus future studies in the tributaries and reservoir.

Phase 2, Task 2—Project Waters Assessment

Analyses in Phase 2, Task 2 will focus on project waters to determine the distribution of contamination in project waters and the extent of species affected by contamination, including additional sport fish species and prey species eaten by other fish and wildlife species. Additional fish species may also need to be collected if fish species collected from the tributaries in Phase 2, Task 1 are different than those collected in Phase 1 from project waters. The same species would be targeted from project waters in this Phase as collected in the tributaries in Phase 2 so comparisons can be made to discern the role of project waters in bioaccumulation. Sediment samples would be collected from project waters to provide information on sources and loading potential.

Phase 2, Task 2A—Sample Collection

Fish species sample collection will use the same procedures and protocols as in Phase 1, Task 1. Sediment samples from deeper project water bodies (e.g., Lake Oroville, Thermalito Afterbay) would be obtained with a core sampler during the spring to early summer prior to the development of anoxic conditions in the hypolimnion. Anoxic conditions allow some contaminants to recycle from sediments to the overlying water. The top six inches of sediments from ten core samples will be composited with teflon spoons into a container provided by the laboratory at each site. Sediments would be collected in the Feather River downstream from the dam within the project area from deposits (point bars, riffle areas, or pools) with teflon spoons into containers provided by the laboratory. Ten samples would be collected from each site and composited into a single sample.

Lake Oroville — Fish and sediments will be collected as much as possible from the same sites from which fish and crayfish were sampled in Phase 1. Additional sport fish targeted for sampling may include brown trout, Chinook or coho salmon, bass, and sunfish (including those species sampled in Phase 1) Prey fish

species (threadfin shad and wakasagi) in the reservoir may be sampled if high contaminant loads are found in Phase 1 in fish that prey on them. Fish will be analyzed using the procedures in Phase 1 for information related to human health from ingestion of contaminated fish as well as whole body analyses of fish for evaluation of effects to wildlife species. Additional sites for sediment samples may be necessary in the main body of the reservoir due to the areal extent and potential for different loading from each arm of the reservoir. The need to collect additional samples will be determined by the variability found in the initial samples.

Diversion Pool — Fish and sediments will be collected from the Diversion Pool near the Diversion Dam. Sport fish targeted for sampling may include rainbow and brown trout, catfish, bass, and sunfish. Fish will be analyzed both for information related to human health from ingestion of contaminated fish as well as whole body analyses of fish for evaluation of effects to wildlife species.

Thermalito Forebay, Thermalito Afterbay, and Oroville Wildlife Area — Sediments will be sampled in these water bodies in the same areas from which fish and crayfish were sampled in Phase 1. Sport fish targeted for sampling may include rainbow and brown trout, catfish, bass, and sunfish. Analyses will include both fish tissues analysis for evaluation of effects to human health and whole body analysis for evaluation of effects to wildlife.

Lower Feather River — Sediments will be collected in the previously sampled sites in the low flow section of the river and downstream from the Afterbay Outlet in the project area. Fish targeted for sampling may include bass, catfish, and sunfish. As with the other sampling sites, fish analyses will include specific tissues and whole body analyses for determination of effects to human health and wildlife species, respectively.

The vulnerability of piscivorous wildlife species to bioaccumulated contaminants will be evaluated in the terrestrial studies if fish eaten as prey are found to contain high levels of contaminants. The assessment of piscivorous susceptibility will be evaluated through a literature review of effects to predatory species from the specific contaminants of concern identified in this study.

Phase 2, Task 2B—Laboratory Analyses

Analyses, laboratories, and procedures for fish and sediment analyses will be the same as in the previous Phases.

Phase 2, Task 2C—Data Interpretation

Data obtained from this Task will be compared to criteria and guidance values to determine the extent of contamination of fish species, need for advisories or additional

information, and effects to wildlife species. The data will also be evaluated to identify potential pathways for bioaccumulation, including contaminant loading, deposition, and cycling.

Phase 2, Task 3. Lower Feather River

This Phase of the study would determine the extent of project related impacts to fish, crayfish, and sediments downstream from the project area. Parameters analyzed would include both metals and organic contaminants that were found to be significant in Phase 1.

Phase 2, Task 3A—Sample Collection

Fish, crayfish, and sediment sample collection will use the same procedures and protocols as in previous Phases which are appropriate for stream sampling. Methods used for fish collection will avoid taking species of concern. Targeted species may include bass, catfish, and sunfish. Analyses will include tissue analyses for determination of effects to human health as well as whole body analyses to determine effects to wildlife species.

Phase 2, Task 3B— Laboratory Analyses

Analyses, laboratories, and procedures for fish and sediment analyses will be the same as in the previous Phases.

Phase 2, Task 3C—Data Interpretation

Data from this Phase will be evaluated to determine the extent of project related effects to fish, crayfish, and sediments downstream from the project area. The data will be compared to criteria and guidance values researched in Phase 1.

Phase 2, Task 4. Phase 2 Reports

Interim output products will be identified through coordination with other work groups to meet their data needs. A report will be prepared at the conclusion of Phase 2 of the study that discusses results of the study, including relationships to criteria and guidelines, implications for human and wildlife health, role of the project, and potential protection, mitigation, and enhancement measures.

6.0 Results and Products/Deliverables

Information from this study will be used to evaluate the effects of the project and project operations on contamination in sediments and bioaccumulation of contaminants in fish and crayfish. Information developed will be presented quarterly to the Environmental Work Group and Task Force for review to evaluate the adequacy and progress of the study.

Data obtained from this study will be compared to criteria and guidelines established for the protection of human health, fish, and wildlife species. Data will be presented in tables and graphs showing the

relationship between concentrations of any contaminants found and the various criteria and guidance values.

Compliance with criteria guidance values will be used to evaluate compliance with Basin Plan objectives, which is necessary for the SWRCB to issue a water quality certification. The water quality certification must be submitted to the Federal Energy Regulatory Commission with the application for a new license for the project.

A draft report documenting findings will be prepared after completion of Phase 1, and a final report with results and recommendations will be prepared at the completion of subsequent Phases, if necessary. The draft report following completion of Phase 1 will include information about potential risks to wildlife from ingestion of contaminated fish species for evaluation in the terrestrial studies.

7.0 Coordination and Implementation Strategy

Coordination with Other Resource Areas/Studies

This study will provide information for evaluation of Issue Sheet W6 (effect of existing and future project facilities and operations on sediment deposition and potential impoundment of metals and toxins, including the potential presence and uptake of methylmercury through the food chain) and will be coordinated with Study Plan SPG1 (Geology Issue G4 - project effect on sediment accumulation upstream of the dam). Information derived from SPG1 will be used to determine the magnitude of potentially contaminated sediment influx into the reservoir.

Issues

This study plan provides the information for evaluation of Issue Statement W6 (effect of existing and future project facilities and operations on sediment deposition and potential impoundment of metals and toxins, including the potential presence and uptake of methylmercury through the food chain. Lake Oroville, fed by tributaries that have a history of gold mining activity, has potential for accumulation of elemental mercury in its basin sediments). This study fully or partially addresses the following Stakeholder issues:

Stakeholder issues fully addressed by SP-W2 Contaminant Accumulation in Fish, Sediments, and the Aquatic Food Chain

- WE 7. Lake Oroville, fed by tributaries that have a history of gold mining activity, has potential for accumulation of elemental mercury in its basin sediments. Potential presence and uptake of methylmercury through the food chain must be assessed
- F6. Effects of existing and future project operations on sediment deposition, erosion, and recruitment through the system (including downstream sediment supply) and associated changes in water quality on the quantity and quality of aquatic habitats within project affected waters.

Stakeholder issues partially addressed by SP-W2 Contaminant Accumulation in Fish, Sediments, and the Aquatic Food Chain

- WE 13. Reduce sediment yields from watersheds in deteriorating conditions and those tributary to eroding channels or hazardous flood prone areas
- WE 41. What coordination for Page 2 #5? -- Could be items along roads that might sweep into the river during floods.
- G4. Project effects on sediment accumulation upstream of the dam.

(Expanded Issues Addressed: GE19, GE22, W6, W9)

8.0 Study Schedule

The study will begin in the spring of 2002. Collection of samples necessary for analyses of the significance of metals and organic contamination in fish, crayfish, and sediments in project waters (Phase 1) should be completed by early summer of 2002. If necessary, additional samples to determine effects from tributary contributions, sediment loads, and downstream effects would occur later in 2002 or the following year. Additional samples may be necessary in subsequent years if sampling attempts fail to collect the requisite samples or if particularly contaminated samples are encountered. A draft report discussing sampling, analytical results, project implications, and recommendations will be completed at the end of each phase of the study.

9.0 References

USGS 1994. Guidelines for collecting and processing samples of stream bed sediment for analysis of trace elements and organic contaminants for the National Water Quality Assessment Program. U.S. Geological Survey Open File Report 94-458.